Before the
FEDERAL COMMUNICATIONS COMISSION
Washington, DC 20554

IN THE MATTER OF	)	
	)	
Spectrum Policy Task Force Report	)	ET Docket No. 02-135
	)	

To: The Commission

COMMENTS OF ARRAYCOMM, INC.

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SUMMARY

ArrayComm applauds the Commission for establishing the Spectrum Policy Task Force and commends the Task Force, itself, for taking an important first step in developing a comprehensive view of the technical and economic requirements for a modernized approach to spectrum regulation, allocation and assignment.

ArrayComm is concerned, however, that the Spectrum Policy Task Force Report (Report) focuses on a particular technology and policy vision for the future, rather than on defining goals for efficient spectrum use and a series of milestones for achieving them. In the absence of such clearly defined targets, it is impossible to determine whether progress is being made and at what rate. Contrary to what is claimed in the Report, technically and economically meaningful metrics and goals can be developed.

The Commission has been historically wise in avoiding technology edicts, allowing industry to innovate in services and technologies while conforming to the Commission's rules. The Report, on the other hand, seems to designate or promote specific novel technologies in the belief that these technologies will enhance the efficiency of spectrum utilization. Regardless of the ultimate utility of these nominated technologies – and we raise some questions in that regard in our Comments – such nomination simultaneously stifles innovation and economically disadvantages all other technologies in the capital markets. We believe that the Commission should engage in an active discussion with industry and academia regarding technology. We also believe that its job is to define spectrum policy and set performance targets. We do not, however, believe that the Commission should mandate technology unless absolutely necessary. The current situation of 3G operators in Europe, forced to adopt a government-mandated technology in return for spectrum access, should serve as a cautionary tale.

Finally, while the uses for unlicensed spectrum have increased significantly in recent years and an increase in unlicensed allocations may be appropriate, we continue to believe that licensed spectrum combined with flexible and exclusive use is the best hope for wide-area services, including wide-area broadband services. In return for the obligations of being a licensee, licensed spectrum affords increased emissions limits and a predictable interference environment, both of which are necessary for commercial-grade wide-area services with tolerable operating economics, and neither of which is characteristic of unlicensed spectrum. Sensible allocation policies and active spectrum management will therefore continue to be important just as they are today. Moreover, since the spectrum suitable for wide-area mobile services is limited and in great demand by commercial, government and scientific interests, and since the preponderance of unlicensed applications are intrinsically intended for short-range, we suggest that any new unlicensed allocations be in spectrum above 3 GHz.

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ArrayComm, Inc. (ArrayComm),[1] submits these comments in response to the Federal Communications Commission's (Commission or FCC) Public Notice[2] seeking public comment on the Spectrum Policy Task Force Report (Report).[3]

I. INTRODUCTION AND OVERVIEW

ArrayComm has reviewed the Report in relation to the Task Force's stated mission:

- Provide specific recommendations to the Commission for ways in which to evolve the current "command and control" approach to spectrum policy into a more integrated, market-oriented approach that provides greater regulatory certainty, while minimizing regulatory intervention.
- Assist the Commission in addressing ubiquitous spectrum issues, including, interference protection, spectral efficiency, effective public safety communications, and implications of international spectrum policies.[4]

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[1] ArrayComm, Inc. is the world leader in smart antenna technology. ArrayComm's patented IntelliCell® technology – based on fully adaptive smart antennas – creates dedicated personal cells of voice or data for wireless subscribers. IntelliCell technology is also the key ingredient behind ArrayComm's innovative i-BURST™ system – the only wireless Internet access system that offers the freedom of mobility with the high speed of DSL at consumer pricing. The company has more than 200 patents issued or pending worldwide.

[2] *Commission Seeks Public Comment on Spectrum Policy Task Force Report*, ET Docket No. 02-135, Public Notice, FCC-322, (rel. Nov. 25, 2002). The comment and reply comment dates were subsequently extended by the Chief, Office of Engineering and Technology pursuant to delegated authority in *Commission Seeks Public Comment on Spectrum Policy Task Force Report*, ET Docket No. 02-135, *Order*, DA 02-3400 (rel. Dec. 11, 2002).

[3] *Spectrum Policy Task Force Report*, ET Docket No. 02-135, (rel. Nov. 2002) (*Report*).

[4] *Id.* at 1.

ArrayComm supports the stated goals of the Task Force, particularly efforts to avoid interference and improve spectral efficiency. However, the Report provides little guidance on how the Commission should "evolve" to a new policy approach, and instead focuses on its vision of a spectrum policy and technology landscape that, in ArrayComm's view, cannot be effected for several years and relies, in large part, on technologies whose efficacy has yet to be proven. That is not to say that some of the concepts and technologies identified in the Report should not be studied and discussed, many appear promising. ArrayComm suggests that rather than provide the FCC a blue print of a future regime, however, the Task Force can and should offer a road map from start to finish that sets goals and targets along the way toward the envisioned regulatory construct. ArrayComm also believes that the focus on an indefinite future creates regulatory and market uncertainty and has a chilling effect on firms, especially small, entrepreneurial companies, seeking capital to exploit efficiency enhancing technologies that can be deployed today.

II. SPECTRUM ALLOCATION AND ASSIGNMENT ISSUES

The Report makes several recommendations to increase access to spectrum, *e.g.*, affording greater flexibility of spectrum use to licensed and unlicensed users, clearly defining the rights and responsibilities of spectrum users, examination of spectrum sharing in the time dimension, creating incentives for efficient use of spectrum, grouping of spectrum "neighbors" with technically compatible characteristics, etc. ArrayComm believes that all of these recommendations are worthy of consideration, but that they must be elements in a balanced scheme.

A. Maximum Spectrum Flexibility

A key element of the new approach discussed in the Report is providing maximum flexibility of spectrum use to licensed and unlicensed operators. Flexible use is a concept that the FCC has come to rely upon more and more. ArrayComm agrees that spectrum users, and particularly licensed users, should be able exploit their spectrum as they see fit, provided their use does not unreasonably impinge on the authorized use of common or adjacent spectrum by others. In essence, affording greater flexibility as to spectrum use must be balanced against clear technical rules. More specifically, the FCC must balance the competing requirements of in-band emissions rules that enable a wide range of flexible and commercially valuable uses of the spectrum against out-of-band emissions (OOBE) rules that that permit co-existence of multiple spectrum users in common and adjacent bands. ArrayComm has championed more stringent and clearly defined OOBE rules and other technical rules in several FCC proceedings.[5] ArrayComm urges the Task Force to develop a proposal for setting technical rules based on safety, and on coexistence with other in-band users[6] and with adjacent band services. The rest – the choice of services and technology, whether to transfer, lease or subdivide, etc. – should be left to the spectrum user. ArrayComm believes such a proposal could be developed and implemented in the near term. Such action would provide greater spectrum flexibility, greater spectrum utility and improve the co-existence of multiple users in the near term, while additional components of a longer-term solution are explored.

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[5] *See*, Comments of ArrayComm in ET Docket No. 00-221, filed Mar. 8, 2001, at 16-43; Reply Comments of ArrayComm in ET Docket No. 00-221, filed Apr. 6, 2001, at 5-6; Comments of ArrayComm in WT Docket 02-08, at 20-25; Reply Comments in WT Docket 02-08, at 13-22; Supplement to Ex Parte Oral Communications in GN Docket No. 01-74, filed Aug. 16, 2001, at 1-4.

[6] In licensed spectrum coexistence refers to coordination at service boundaries. In unlicensed spectrum, it refers to coexistence of co-channel devices such as cordless phones and wireless LANs.

B. Allocation of Additional Unlicensed Spectrum

The Report urges the allocation of more spectrum for unlicensed devices and the adoption of a spectrum "commons," where an unlimited number of unlicensed users would share frequencies pursuant to usage rights governed by technical standards or etiquettes, but with no right to protection from interference. ArrayComm does not oppose more unlicensed spectrum or the commons model, but it does have reservations.

The current enthusiasm favoring additional unlicensed spectrum often focuses on WiFi, the popular name for the IEEE 802.11b wireless LAN standard. There is a belief that encouraging WiFi deployment will stimulate the deployment of broadband services in the US. However, as briefly explained below, WiFi has limitations on range and capacity that preclude it from providing ubiquitous broadband access to the mass market (individuals and homes).

WiFi is a short-range wireless link, often viewed as a substitute for in-wall cable connections to different fixed locations in a residence or in an office. With WiFi, the user is free to move about the office with a modem that plugs into a laptop computer, enabling a worker to move from office to office or to a conference or meeting rooms while remaining connected throughout the premises. A more novel use of WiFi systems is to provide public access to the Internet via wireless networks in public spaces. This has been dubbed "hot-spot" service, where a user with a modem and a laptop can connect to the Internet via a nearby WiFi access point that is then connected to a network that connects to the Internet.

WiFi uses unlicensed spectrum, and falls into the category of Part 15 devices. For that reason, WiFi is prone to interference from other unlicensed users, including other WiFi users, resulting in congestion and degradation of service. The uncontrollable nature of interference in unlicensed bands is a key disadvantage in commercial applications. Without the ability to manage and predict interference, only the most limited guarantees regarding service quality are

possible. Highly variable service quality is acceptable in many casual applications, but not in commercial ones.

The limited range of each WiFi device is a result of two effects. First, as a Part 15 service, WiFi's transmit power is limited to assure that devices cannot create unacceptable levels of interference to the many other devices that may be in operation in the vicinity of WiFi devices. Second, because WiFi, or 802.11b, technology was specifically designed for low-power, short-range applications, its radio protocol is not suited to long range, mobile applications, regardless of transmit power.[7]

As a result, the range of each WiFi access point is only a few hundred meters. To provide more than "hot-spot" service, one would have to deploy hundreds of thousands of access points to give even a fraction of the level of coverage that we receive from cellular service providers nationwide. (About 20,000 cellular sites are sufficient to give nationwide coverage for cellular voice services across the US.) In other words, WiFi is a great technology for localized coverage and "hot-spots", but cannot provide the ubiquity of coverage that consumers require for broadband access to the Internet.

The WiFi example illustrates why ArrayComm is wary of the indiscriminate call for more unlicensed spectrum as the solution to the slow growth of broadband access. As noted in the Report, "certainty regarding one's ability to continue to use spectrum, at least for some foreseeable period, is an essential prerequisite to investment, particularly in services requiring significant infrastructure installation and lead time."[8] ArrayComm believes that statement is true of any service that would provide broadband service to the public. For this reason, ArrayComm

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[7] The WiFi protocol lacks equalization support, for example, which is required for mobile applications. Long-range, fixed, line-of-sight WiFi operation is practical with increased transmit power.

[8] *Report* at 23.

cautions against the uncritical exaltation of unlicensed spectrum currently in vogue. Licensed spectrum combined with flexible and exclusive use is the best hope for wide deployment of alternative broadband networks. However, if the FCC determines, after careful consideration, that additional spectrum for unlicensed use is in the public interest, it should avoid the mobility bands[9] and confine unlicensed use to bands where spectrum scarcity is relatively low and the inefficiencies of unlicensed use would have less impact.

C. Spectrum Rights and Responsibilities

Many of the techniques identified in the Report as having the potential to improve access to spectrum and avoid interference envision the sharing of spectrum. Given the current lack of available spectrum below 3 GHz, spectrum sharing on a non-interfering basis is a reasonable option to explore. But before concepts such as the use of transient "white spaces"[10] in licensed bands, "underlays" and easements are considered, the rights and responsibilities of spectrum licensees must be clarified. The primacy and protection of a licensee's rights must be clearly understood by the licensee and all potential sharers of the band. Any rights conferred upon the unlicensed sharer must not devalue or impair the licensed user's operations, the ability to guarantee service quality for example. Without these basis principles, sharing cannot succeed and spectrum chaos will follow.

Assuming the rights and responsibilities of spectrum users are clarified and established as the foundation of any sharing procedures, consideration of the shared use concepts identified in the Report could then be undertaken. Again, however, ArrayComm believes considerable time

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[9] ArrayComm urges the FCC not to allocate additional unlicensed spectrum in the bands below 3 GHz.

[10] Herein, we segment the Report's concept of "white space" into two subcategories. We denote spectrum that is normally in active use for radio communications but may, for a brief period extending perhaps from milliseconds to, perhaps, days, be unoccupied as "transient white space." Spectrum that is not in active use because it is allocated to a defunct service, or because it is unusable due to the presence of sensitive adjacent-band operations, is denoted as "persistent white space."

will elapse before concepts like transient "white spaces" and the "commons" can be practically implemented, particularly in spectrum below 3 GHz. Such concepts must be defined, researched and have their practical utility assessed before they can be used as the basis for national policy. That process will take years. In the mean time, ArrayComm suggests that the FCC exploit existing "white spaces" through improved allocation policies, such as the expected reallocation of unused or underused MSS spectrum, or by reallocating vacant broadcast spectrum, or through improvements in receiver standards.

The "commons" concept that is favored by the Task Force and others is an interesting but unproven model for radio spectrum. Again this concept cannot be implemented without much study and debate. The notion and the technologies required to implement and enforce it are clearly not ready for spectrum already straining to support a large number of competing and worthy interests, *e.g.,* spectrum below 3 GHz. However, ArrayComm would not oppose a near term experiment using the "commons" model, if undertaken in lightly used spectrum such as that above 5 GHz.

D. Inter-agency Coordination

The FCC and the National Telecommunications and Information Administration (NTIA) have worked very hard to find spectrum that can be reallocated from government to commercial use. However, that process has been slow and, to a large degree, secretive. Of course certain information important to national security should be withheld. However, ArrayComm believes that a more efficient and transparent process can be established. The Task Force should assist the FCC in improving this process.

II. TOWARD SPECTRAL EFFICIENCY

In the Report, the Task Force appears to be of two minds regarding the manner in which efficiency can be increased. In some areas, it takes a policy-based approach, for example in discussing concepts such as the "commons" or improved definitions of spectrum rights. In other areas, it appears to "designate" or promote certain technologies as the path to efficiency. In ArrayComm's view, a policy-based approach with performance targets is far more appropriate, and ultimately far more effective, than one that bets on certain technologies and then waits for an eventual outcome.

A. Performance Metrics

Improving the efficiency of spectrum usage will be an evolutionary process, requiring technical and economic performance targets that evolve over time, as well as metrics that can be used to gauge the effectiveness of technologies and spectrum policy. Contrary to what is stated in the Report, meaningful performance targets can be set. ArrayComm believes the Task Force should assist the Commission by suggesting such targets.

The Report states that "technical efficiency does not provide any information with respect to economic efficiency."[11] This is simply not true. The CDMA operators in the United States and elsewhere who are replacing IS-95 systems with 1xRTT systems are doing so because the new systems support roughly twice the number of voice calls per unit of spectrum, or twice the technical efficiency, of their predecessors. This technical improvement permits the operator to double the quantity of billable services per base station. Many of the economic arguments in the industry made for one technology versus another are based on technical efficiency.[12]

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[11] *Report* at 21.

[12] *See, e.g.,* http://www.qualcomm.com/main/whitepapers/WirelessMobileData.pdf ("The Economics of Mobile Data").

It is true that a single metric and a single performance level will not be appropriate for all services. One metric may be required for voice systems, *e.g.,* simultaneous calls/Hz/cell. Another may be required for data services, *e.g.*, bits/second/Hz/cell. All two-way commercial and consumer services – which use a significant portion of the spectrum actively managed by the Commission – could certainly be organized into a small number of categories for which meaningful spectral efficiency metrics could be created and used to determine not only the baseline performance of today's systems, but achievable targets for future systems.

B. Technical Policy

A policy that coupled performance targets with the Report's policy recommendations would lead to increased efficiency in spectrum usage. ArrayComm strongly supports the following recommendations from the Report.

- Grouping Similar Technologies[13] -- Spectrum should be reallocated over time so that mutually non-interfering (or low interfering) technologies are spectrally adjacent and spectrum is available for each major class of technologies, *e.g*., Broadcast, FDD cellular and LMR, TDD cellular, *etc*.

- Receiver Performance Specifications[14] -- The Commission's rules encourage operators and systems designers not to radiate energy needlessly.[15] Rules should similarly be written to encourage operators and systems designers to employ equipment that has interference immunity (selectivity and blocking specifications) that are consistent with modern engineering practice. The Report speaks of exploiting "white space"[16] in the spectrum. Persistent white space would become easier to exploit – in certain cases it could be reallocated or reassigned on a permanent basis – if receiver performance were improved.[17]

- Clear Definition of Spectrum Rights -- A clear definition of spectrum rights, including in-band and out-of-band emissions levels similar to those listed at page 18

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[13] *Report* at 4, 22.

[14] *Id.* at 5, 31.

[15] *See*, *e.g.*, 47 C.F.R. Section 15.15(c).

[16] *Report* at 10.

[17] On the other hand, transient white space, in our view, is a useful concept for visualizing an opportunity for which there is not yet a clear practical means of exploitation.

of the Report, is needed. ArrayComm would further propose that in-band and out-of-band emissions be specified in units of EIRP Power Spectral Density which has the advantages of being easy to measure for compliance testing, and easy for spectral neighbors to use in coexistence calculations.

C. On Mandating Technology Rather Than Performance

The Commission has been extremely wise in its general practice of establishing broad technical criteria for the use of any particular band, permitting manufacturers, operators and consumers to innovate and experiment in using it. This is true for unlicensed spectrum, as evidenced by the popularity of wireless LANs, and for licensed spectrum, as evidenced by the popularity and diversity of cellular services. The results of an alternative regulatory approach, in which regulators mandate the details of permissible technology and services, can be seen, for example, in the state of European 3G operators, limited by regulation in their technology choice, and provide further confirmation of the correctness of the Commission's approach to date.

The Report, however, identifies and promotes specific technologies based on a belief that they will contribute to efficient utilization of the spectrum. Many of these technologies may ultimately be useful. However, the Report addresses only a limited set of technologies and the actual utility of many of them is still unknown. To illustrate this point, we briefly comment on several of the Report's "designated" technologies.

The Report makes frequent mention of Software Defined Radios[18] (SDRs) and frequency agile technologies.[19] SDR refers very broadly to a class of radio solutions in which one or more portions of a radio's baseband and radio frequency (RF) processing are implemented in software on programmable devices. Almost all consumer radio devices today, cellular phones for example, contain significant baseband software content and are generally considered to be SDRs.

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[18] *Report* at 14.

[19] *Id.* at 19.

The same will be true of future devices. But SDR technology does not necessarily improve the efficiency of spectrum usage.

The Report envisions a future SDR technology that is agile with respect to protocol, modulation, center frequency and operating bandwidth. Such a technology would require major technology advances in RF components to be feasible at all, and additional manufacturing and technology advances to be feasible at consumer price points and form factors. Even if the RF, processing and packaging technology were available, it is not clear that the Task Force's vision of SDR would be appropriate for all applications. Radio protocols required to search for an available piece of spectrum, or wait until one became available, might well have poor latency and jitter characteristics. Finally, such SDRs would also require a software-defined infrastructure to communicate with. The task of building economical, frequency and bandwidth agile base stations presents its own, potentially insurmountable, set of challenges.

SDR will continue to be an important technology, but it is not at all clear that it will satisfy the ambitious goals set for it in the Report. More investigation is required and the vision for SDR offered in the Report will not be commercially realized for many years in any event.

Another technology "designated" in the Report is one that "maintain[s] as close to uniform power flux density signal levels as possible throughput a service area."[20] Such technology severely impacts the utility, and may even prevent the use, of power control techniques, one of the primary methods used in radio networks to minimize interference and maximize spectral efficiency. ArrayComm is not aware of any studies of the comparative efficiency benefits of this technology and power control techniques; this technology may in fact

[20] *Id.* at 20, 32.

decrease spectral efficiency in many applications. Again, more investigation is required and the timing of any benefits from this technology is indefinite.

Similar comments could be made regarding the other technologies "designated" in the Report such as mesh networks.[21] Any one of these technologies might be critically important, or critically limiting, to some future application. The same is true for other technologies not mentioned in the report. The Commission should engage in an active discussion with industry and academia regarding technology, but it should stop short of promoting particular technologies and instead set broad performance targets for spectrum use to create an environment that promotes innovation.

D. Interference Temperature

Traditionally, interference regulations have been based on transmitter emissions that are relatively easy to measure, but whose effects on distant receivers is difficult to predict. Interference temperature is appealing in that it is a direct measurement of the interference at the "victim" receiver. It will be much more difficult to measure, however, to mitigate and to enforce, than transmitter-based emissions. In real-word applications, the following basic and open issues must be addressed. What time and space density of interference measurements will be required to verify compliance? If the interference temperature has been exceeded at some location, which of the hundreds of potential contributing interferers should stop emitting? If the interference temperature has been exceeded at some location, how will the contributing interferers be identified? And so on.

[21] *Id.* at 36. A message transiting a mesh network is transmitted many times as it moves from one node in the mesh to the next, *increasing* the amount of spectrum, more precisely radio time-bandwidth product, required to convey the message in comparison to a non-mesh architecture.

These questions indicate clearly that significant further consideration is required before "the Commission shift[s] its current paradigm for assessing interference"[22] to a scheme based on interference temperature.

III. CONCLUSION

The Task Force has expended significant time and effort in the process that resulted in the Report. There is much to be praised with respect to the Task Force's commitment to re-think the Commission's approach to policy and technical rules. However, ArrayComm is concerned that based on the Report, the Commission might neglect the existing technologies and interim steps that can improve access to spectrum and interference avoidance today, with attendant near-term benefits.

The Report also could be interpreted by a skeptical mind as a search for technical and policy tools that would allow the Commission to abdicate much of its responsibility to manage the spectrum. That interpretation would be as follows: With the anticipated advances in technology everybody can use spectrum in anyway they wish, without fear of impinging on the rights of others. That may be a worthy goal, but by today's lights it is Utopian in the extreme. Nothing should suggest to the Commission that it need not make the tough decisions on spectrum allocation and interference protection. In fact, ArrayComm believes that those decisions will have as much or more to do with the evolution to more efficient spectrum use than will the technologies embraced in the Report.

ArrayComm would like to see the Task Force spend more time on policy solutions that can be implemented today or within the near term, and less time on concepts and techniques that are unproven and may be superseded by other more effective technologies. By expressing its

[22] *Report* at 27.

confidence in industry and academia's ability to innovate and assist the Commission in meeting its spectrum management goals, the Task Force could in fact spur the availability of investment capital for innovative and efficiency-enhancing technologies that can be deployed today.

It is fine that the Report addresses long-term goals, but ArrayComm urges the Task Force not to ignore what can be done *today*.

Respectfully submitted,

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